

# Elbow Injuries in the Throwing Athlete: A Review

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## Abstract

Overhand-throwing motions can create supraphysiologic stresses on the elbow. Repeated stresses often result in overuse injuries affecting the elbow, which are commonly seen in throwing athletes. Noted problems include medial epicondylitis, valgus extension overload, olecranon stress fractures, ulnar neuritis, and damage to the ulnar collateral ligament. Symptoms of pain or numbness at presentation vary in location depending on the injury. Successful diagnosis is typically made using results of physical examinations of elbow, wrist, and arm extensions; results of tests for valgus instability; and findings radiographs can all help indicate the problem. However, pathological features of these injuries are not always clear, which can complete effective treatment. Baseball pitchers are often discussed when investigating overhand-throwing athletes; yet the current review examines players of various overhand-throwing sports to help assess causes, diagnosis, and treatment of related elbow injuries.

## Introduction

The overhand-throwing motion can create supraphysiologic stresses on the elbow, with most injuries considered attritional rather than acute or traumatic.<sup>1</sup> During the acceleration phase of throwing, the elbow reaches an angular velocity of 3000 degrees per second. This motion creates three primary forces across the elbow. A tension force occurs along the medial side of the elbow (ulnar collateral ligament [UCL], flexor-pronator mass), which has been measured up to 64 N. The second force created during throwing is a shear stress in the posterior compartment, owing to excessive valgus moment caused by the angular velocity of the elbow. Shear forces result in excess stress in the posteromedial olecranon and trochlea. Finally, a compression force on the lateral aspect of the elbow is created, balancing the tension on the medial side. Up to 500 N of compression in the radiocapitellar joint has been noted in some studies.<sup>2,3</sup>

Subsequently, repeated stresses may result in overuse injuries affecting the elbow for overhand-throwing athletes. Although throwing athletes are commonly thought of as

baseball pitchers, the current review also examines players of other sports (eg, javelin throw, American football, tennis, and water polo) to help assess a wider spectrum of related elbow injuries. Problems discussed include medial epicondylitis, valgus extension overload (VEO), olecranon stress fractures, ulnar neuritis, and UCL injury.

## Medial Epicondylitis

Medial epicondylitis is the result of overuse of the flexor-pronator mass and can be caused by repetitive throwing. Commonly affected areas include the pronator teres and flexor carpi radialis origins. This inflammation may also result in irritation of the ulnar nerve. Patients typically present with pain over the medial epicondyle. On physical examination, this pain can be reproduced with resisted wrist flexion.

This condition is up to five times less common than lateral epicondylitis and often more difficult to treat. First line of treatment should include the use of non-steroidal anti-inflammatory medication and counter-force bracing. Some studies support the use of kinesiotaping for conservative management. Corticosteroid injections may also be considered, which should be performed in the peritendinous and synovial tissues to avoid tendon injury.

Surgical treatment is usually withheld until the patient has undergone 6 months of conservative treatment without success. Operative treatment involves debridement of the flexor-pronator attachment at the medial epicondyle. Most patients experience symptom relief postoperatively, but results can worsen if ulnar nerve injury remains unaddressed.<sup>4</sup>

## Valgus Extension Overload

VEO, also known as pitchers' elbow, is a condition characterized by pathological features in the posterior elbow. VEO is caused by repetitive shear forces during throwing motion. Bony changes, including formation of posteromedial olecranon osteophyte, occur after attenuation of the UCL. Increasing laxity in the UCL places additional stress in the posterior elbow through the throwing motion (Figure 1). Both the olecranon and

the UCL contribute to valgus stability of the elbow. One study<sup>5</sup> found that all pitchers showed reactive changes to the subchondral bone as a result of this activity. Thus, additional instability at the elbow created by UCL injury contributes considerably to the pathological features causing VEO.



**Figure 1.** 3D reconstruction of computed tomography showing the elbow, revealing evidence of valgus extension overload, highlighted by notable posteromedial osteophyte formation on the olecranon.

Patients with VEO typically present with pain in the posterior elbow, particularly in full extension. Baseball pitchers specifically may note pain during the deceleration phase of throwing. On physical examination, these patients have tenderness to palpation in the posteromedial olecranon. Furthermore, baseball pitchers may have crepitus through the range of motion, particularly if loose bodies have formed in the posterior elbow joint. Patients will also have pain with forced elbow extension.

Treatment should include an initial period of rest and trial of non-steroidal anti-inflammatory medication. Baseball pitchers can also be instructed to correct poor technique. Studies have noted certain throwing mechanics may place athletes at higher risk for UCL- and VEO-related injuries. If nonoperative treatment is unsuccessful, patients typically undergo surgical procedure. However, care must be taken to avoid resecting native ulna, which can lead to increased valgus instability at the elbow.<sup>6,7</sup> Use of arthroscopic and open techniques have been described. The procedure consists of debridement of osteophytes and removal of loose bodies.<sup>10</sup>

Special attention must be paid to the UCL during surgical treatment of VEO. Patients with considerable UCL insufficiency are at a high risk for unsuccessful treatment with isolated posterior elbow debridement. Studies have described up to 25% of Major League Baseball pitchers who require UCL reconstruction after undergoing isolated posterior elbow debridement.<sup>8,9</sup>

## Olecranon Stress Fracture

Olecranon stress fracture is a rare baseball-related injury, which may be the result of repetitive shear forces in the posterior elbow similar to that described of VEO. In adolescent patients, traction of the triceps muscle with repetitive throwing can play a role, pulling against the olecranon apophysis. The fracture typically arises from the articular surface, involves the epiphyseal plate, and propagates in a dorsal and proximal direction. Patients present with pain in the posteromedial olecranon when throwing, which is usually relieved with rest. Tenderness and swelling over the olecranon may also be noted. The arm should be tested for signs of valgus instability.

These fractures can often be treated conservatively, with rest and splinting methods. Electrical bone stimulation may also be considered. For patients that do not experience healing in 3 to 6 months, surgical treatment is recommended. A single intramedullary screw across the fracture site or unfused apophysis is usually sufficient for successful treatment.

Patients with olecranon stress fractures related to throwing, like those with VEO, frequently have concomitant UCL or medial epicondyle injury, and special attention should be paid to this diagnosis during workup of these patients.<sup>11,12,13</sup>

## Ulnar Neuritis

Repetitive throwing can result in inflammation of the ulnar nerve. This condition commonly arises with other medial-sided elbow injuries. Patients typically present with numbness in the ulnar nerve distribution after throwing. On physical examination, patients may have a positive Tinel sign at the cubital tunnel. Results of the elbow flexion test are positive when the elbow flexion for 60 seconds reproduces symptoms. Findings of nerve conduction studies may aid in the diagnosis. Similar to ulnar neuritis from other causes, treatment is typically surgical and consists of *in situ* decompression versus transposition. No clear consensus exists regarding optimal treatment. Some authors advocate for more aggressive indications for transposition in throwing athletes owing to the stresses placed at the elbow during the throwing motion, but there is little data to support this.<sup>1,14,15</sup>

## Ulnar Collateral Ligament Injury

Injury to the UCL is caused by overuse resulting from repetitive valgus stress of throwing motions. The late-cocking and early acceleration phases of throwing are most notable for these stresses.

The UCL is composed of three bundles: anterior, posterior, and transverse. The ligament functions to resist valgus and distraction at the elbow joint, in which the anterior bundle provides the most notable contribution. It originates at the medial epicondyle of the humerus and has its attachment at the sublime tubercle of the ulna.

Throwers who injure the UCL may experience a 'pop.' The injury is associated with a loss of velocity and accuracy when throwing. Patients also experience medial-sided elbow pain during the late-cocking and early acceleration phases of throwing. On physical examination, patients have tenderness over the medial epicondyle. The moving valgus stress test of O'Driscoll is the most sensitive examination for diagnosing UCL injury. During the test, the patient's elbow is flexed with the forearm supinated and a valgus stress is delivered by the examiner. The patient is then taken through elbow range of motion. Results are considered positive when the patient experiences pain, instability, or apprehension with the elbow flexed between 80° and 120°.

Radiographs may be obtained during workup but are typically not useful for diagnosis of ligament injury. Gravity stress radiographs may be considered, and medial-joint line widening greater than 3 mm may indicate a UCL injury. Magnetic resonance imaging (MRI) is the most helpful imaging technique, and sensitivity and specificity are increased with addition of arthrogram. A capsular T sign can be appreciated on MRI as contrast leaves the joint (Figure 2).



**Figure 2.** Capsular T-sign on magnetic resonance imaging, indicating ulnar collateral ligament rupture (white arrow).

Surgical treatment of UCL injuries are rare because mostly high-level throwers who wish to continue competitive sports are willing to undergo extensive rehabilitation. The most sizable population available for

study is Major League Baseball pitchers, in which up to 33% of active pitchers have undergone UCL reconstruction. Use of multiple techniques have been described for UCL treatment. In general, reconstruction of the ligament is favored over direct repair. A muscle-slitting approach is also helpful, as this avoids injury to the flexor-pronator mass and the ulnar nerve.

In general, performance of UCL reconstruction has shown successful results. Cain et al<sup>16</sup> reported an 83% return to previous level of competition in the largest series to date. Average time to begin a throwing program postoperatively is 4.4 months, and average time to return to full competition is nearly 12 months.<sup>16</sup> Complications after surgery can be up to 20% but are frequently minor, including transient ulnar neuropraxia. Revision rate has been reported between 1% to 5%, with a 0.5% risk of fracture at the tunnel sites. Results of several studies have suggested no significant difference in outcomes between surgical technique, autograft choice, or patient sport or level of competition.<sup>17</sup> In general, reviews of baseball pitchers returning to competitions have shown an ability of patients to compete at high levels. However, on average, baseball pitchers have a decreased pitch velocity and diminished position-related statistical measures.<sup>18,19</sup> These effects are worse in athletes older than 35 years.<sup>19</sup>

Outcomes for revision UCL reconstruction are generally less successful. Average time to recovery is significantly longer, and rates of return to high levels of competition are lower.<sup>20</sup> Much research is currently being dedicated to preventing these potentially career-ending injuries. Many baseball pitchers use altered throwing mechanics to create additional power during their throwing motion. Early rotation of the torso (before foot strike) has been particularly associated with UCL injury.<sup>21</sup> Pitch velocity alone does not play a factor, but baseball pitchers who throw a high percentage of fastballs are at higher risk for UCL injury, perhaps owing to the higher angular velocity associated with maximum throwing effort.<sup>22</sup> In one study,<sup>22</sup> for every 1% increase in fastball percentage thrown, there was a 2% increased risk of UCL injury. Limitations in glenohumeral passive range of motion has also been implicated.<sup>23</sup>

## Conclusion

Elbow injuries resulting from overhand-throwing motions typically occur over time from repeated stress at the region.<sup>1</sup> Reported problems include medial epicondylitis, VEO, olecranon stress fractures, ulnar neuritis, and damage to the UCL. Pathological features are often unclear for each injury; however, successful diagnosis can often be made when noting symptoms of the patient at

presentation, results of physical examination, and findings of radiographs. For UCL injuries, an MRI is considered the most helpful for diagnosis. Generally, surgeons should be aware that patients with olecranon stress fractures and VEO typically have concomitant UCL or medial epicondyle injuries, which can help with successful diagnosis.

Treatment of each injury is initially conservative, with surgical methods explored if observational techniques are unsuccessful. On the other hand, patients with ulnar neuritis are often treated operatively at first, yet no technique has been proven more effective than another.<sup>1,14,15</sup> Although rare, injury to the UCL is perhaps the most devastating elbow injury of throwing athletes. Baseball pitchers with UCL damage typically undergo successful UCL reconstruction, with minor complications, yet on average have decreased pitch velocity and diminished position-related statistical measures.<sup>18,19</sup>

Overall, successful diagnostic and treatment methods have been established for most elbow injuries associated with throwing athletes. However, further clinical studies on various types of throwing athletes may help illuminate the pathological features of these problems to help return to previous levels of high-competitive activity.

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## Conflict of Interest

The author reports no conflicts of interest.

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